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1220 WASHINGTON AVE., STATE CAMPUS, ALBANY, NEW YORK 12232

TECHNICAL REPORT 84-4

WEARING SURFACES FOR STEEL ORTHOTROPIC BRIDGE DECKS

materials bureau technical services division

JUNE, 1984

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TECHNICAL REPORT 84-4

WEARING SURFACES FOR STEEL ORTHOTROPIC BRIDGE DECKS

FIRST INTERIM REPORT

CONDUCTED IN CONJUNCTION WITH
THE U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EXPERIMENTAL FEATURE PROJECT NUMBER 80-09

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June, 1984

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ABSTRACT

The purpose of this study is to evaluate the protective, bonding and durability characteristics of wearing surfaces on steel plate bridge decks. This report describes the design, construction and performance of two systems applied on two orthotropic design bridge decks in 1981.

The first system was constructed on the South Bay Bridge near Whitehall, NY. The wearing system consisted of coating the steel deck with an inorganic zinc-rich silicate paint for corrosion protection; the application of an asphalt emulsion tack coat; a first course paving (1-1½") of asphalt concrete; the application of a fabric membrane for waterproofing and crack control; and paving a second course wearing surface of asphalt concrete (1-1½"). A performance evaluation performed 10 months after completion shows failure of this system by disbondment and sliding of the asphalt wearing course over the steel deck plates.

The second system was installed on the Webster Street Bridge between the Cities of Tonawanda and North Tonawanda, NY. This system consisted of applying a preformed sheet waterproofing membrane to the steel deck and paving a 2 inch asphalt wearing surface. No problems were encountered during construction and the system is satisfactory after 2 years of service.

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I. INTRODUCTION

Background

Three orthotropic steel plate deck bridges have been constructed by the New York State Department of Transportation. Each of these structures exhibited signs of distress in their wearing surfaces shortly after initial construction was complete.

One of these bridges is located near Syracuse, NY and carries Peck Road over NY State Route 690. It is owned and maintained by the County of Onondaga. It's original wearing surface, a polyurethane surfacing, failed due to abrasion and was overlaid by County forces in October, 1977, using a liquid membrane waterproofing system and a 2 inch thick asphalt wearing surface. This bridge is constructed on a level grade and carries only local traffic. The new waterproofing membrane and wearing surface were performing satisfactorily as of January, 1981.

The two remaining orthotropic bridges are owned and maintained by the New York State Department of Transportation. Each of these bridges is constructed on a crest vertical curve and subject to more severe traffic conditions. Premature deterioration of the deck wearing surfaces in the form of shoving, cracking and delamination has required continual maintenance on each of these structures. In an attempt to correct these problems, each bridge was reconstructed in 1981 with an experimental wearing surface system.

Purpose and Scope

This study is being conducted in conjunction with Experimental Feature Project NY 80-09 "Wearing Surfaces for Steel Orthotropic Bridge Decks." The purpose of the study is to evaluate the protective, bonding and durability characteristics of wearing surfaces on steel plate bridge decks. This report describes the design and rehabilitation of two orthotropic bridge decks using two experimental wearing surface systems.

II. TEST SITES AND WEARING SURFACES

Whitehall Test Site (South Bay Bridge)

This structure is located on NY Route 22, north of Whitehall, over the South Bay of Lake Champlain. The original bridge was built in 1973 on a crest vertical curve, connected by 2% grades. The structure is 530 feet long by 42 feet wide and consists of six - 88'4" long simple spans. The original design specified 7/16" thick steel deck plates, stiffened in two mutually perpendicular directions by a system of longitudinal and transverse ribs welded to them. Abutting prefabricated deck sections were bolted together. On the South Bay Bridge, the longitudinal stiffeners consisted of closed ribs of a trapezoidal cross section spaced on 24" centers; transverse stiffeners, spaced on 11'0½" centers, consisted of floor beams which used the steel deck as their top flange. Figure 1 is a schematic of this orthotropic design.

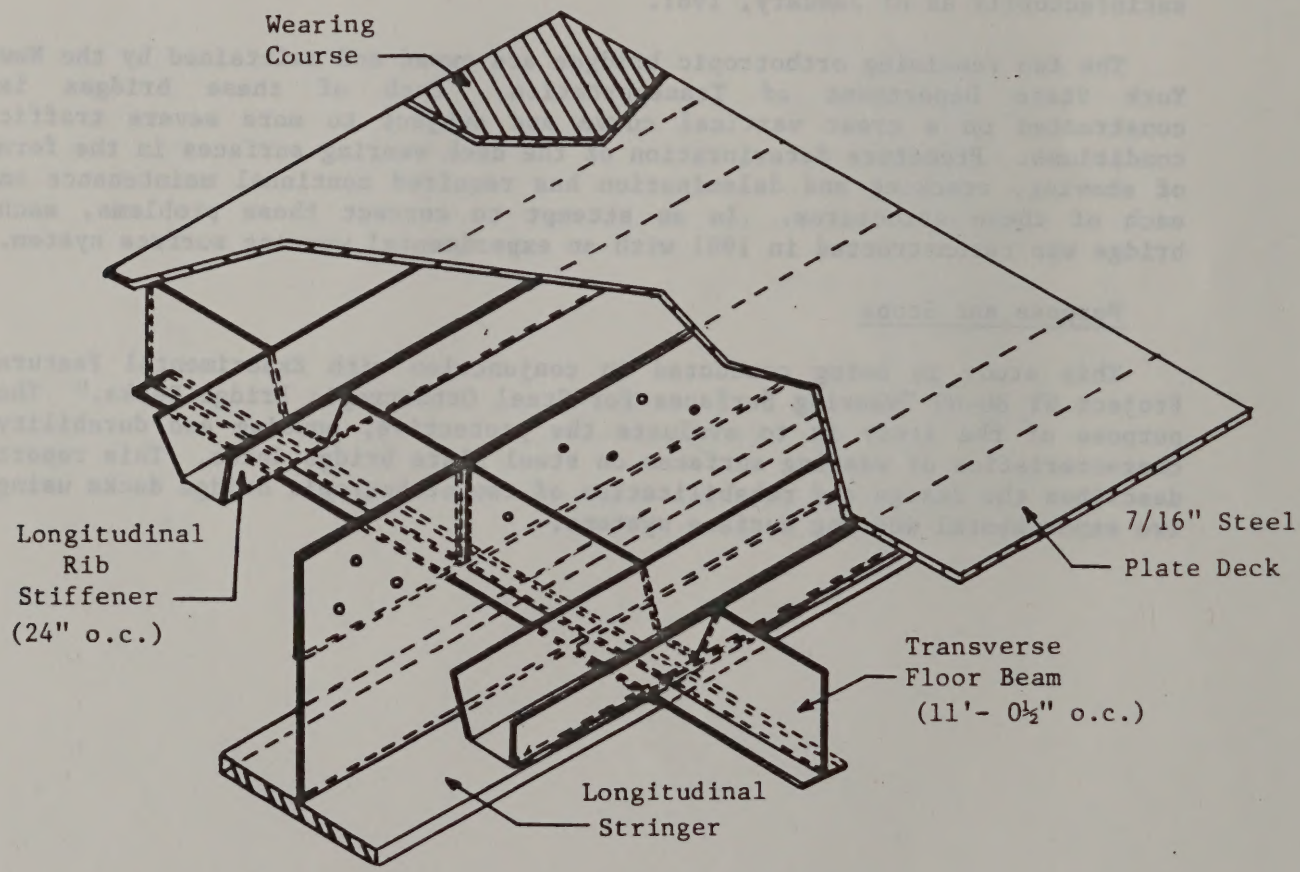

FIGURE 1 - ORTHOTROPIC STEEL DECK PLATE DESIGN
WHITEHALL TEST SITE (SOUTH BAY BRIDGE)

The original deck wearing surface consisted of a bituminous epoxy membrane coating for corrosion protection of the steel deck plates, paved over with 1 5/8 inches of a modified asphalt mix. The bituminous epoxy was applied in two coats to a total thickness of approximately 100 mils. Coarse aggregate (primary size ¼ inch) was broadcast into the second coat to provide aggregate interlock to reduce slippage of the asphalt overlay. The subsequent paving operation consisted of applying an asphalt emulsion tack coat and the placement of a 1 5/8 inch thick asphalt sheet mix, reinforced with latex and asbestos.

Within one year of completion, cracking in the wearing surface and underlying protective coating occurred. These defects were primarily located over the longitudinal joints formed by abutting steel deck plates. Excess flexibility, due to the lack of adequate load distribution between the bolted deck sections was thought to create this condition. The resultant cracking permitted the entry of moisture to the steel plate deck causing some minor corrosion and promoting large scale deterioration of the wearing surface. Figure 2 shows the condition of the wearing surface prior to reconstruction.

Figure 2. Deteriorated Deck at South Bay Before Reconstruction.

In 1981, the South Bay Bridge was reconstructed under Contract No. D96636, P.I.N. 1130.27.321, F.A. Project No. FR-73 (102). This work consisted of removing the existing wearing surface; stiffening the steel deck plates to reduce flexibility; and placing an experimental wearing surface system. Stiffening was accomplished by adding angles between the transverse stiffeners and the longitudinal stringers, and by welding the longitudinal joints between abutting deck panels. The new wearing system consisted of coating the steel deck with an inorganic zinc-rich silicate paint for corrosion protection; the application of an asphalt emulsion tack coat; a first course paving (1-1½ inch thick) of asphalt concrete; the application of a proprietary fabric membrane for waterproofing and crack control; and paving a second course wearing surface of asphalt concrete (1-1½ inch thick). The proprietary membrane in this system was "Petromat fabric" (5 oz/s.y.), Bridge Deck Membrane Grade, as manufactured by Phillips Fibers Corporation, Greenville, South Carolina.

Figure 3 is a transverse section of the rehabilitated South Bay deck. Appendix A contains the Contract Specifications and Notes pertaining to the work items.

Webster Street Test Site - Cities of Tonawanda and North Tonawanda

This structure carries Webster St. over the Barge Canal between Erie and Niagara Counties. The orthotropic deck was originally constructed in 1978. The bridge is 214½ feet long by 50 feet wide and consists of two 107'3" simple spans, built on a crest vertical curve connecting 3.3% and 3.8% grades.

The orthotropic design of the Webster Street Bridge is different from that of South Bay. The individual 3/4 inch deck plates are connected by a bolted splice plate on the underside and welded together on the topside. Heavy transverse floor beams, spaced 2'-9" on center are welded to the deck plates that in turn act as the upper flange. Longitudinal diaphragms (stiffeners) consist of W8 x 17 beams spaced 8'-6" on center. These diaphragms are bolted to the web of the transverse floor beams. This design provides a steel deck that is significantly more rigid than that at South Bay. Figure 4 shows the underside construction of the Webster Street Bridge.

The original wearing surface on this bridge was similar to that used on South Bay. A two coat application of bituminous epoxy membrane (with aggregate) was applied to the steel deck and paved with a 2 inch thick, standard bituminous concrete mix. No modifiers or reinforcers were added to the asphalt material.

Failure occurred with this system within one year of completion primarily in the form of shoving on the 3.8% grade. Cores taken from the wearing surface indicated two failure modes. The asphalt was sliding directly over the top of the bituminous epoxy membrane and the epoxy membrane was delaminating between the first and second coats. In this latter case the two applications of epoxy, which were placed in cool weather, had failed to completely cure, resulting in slippage (shear) at their interface. Figure 5 shows the condition of the wearing surface prior to reconstruction.

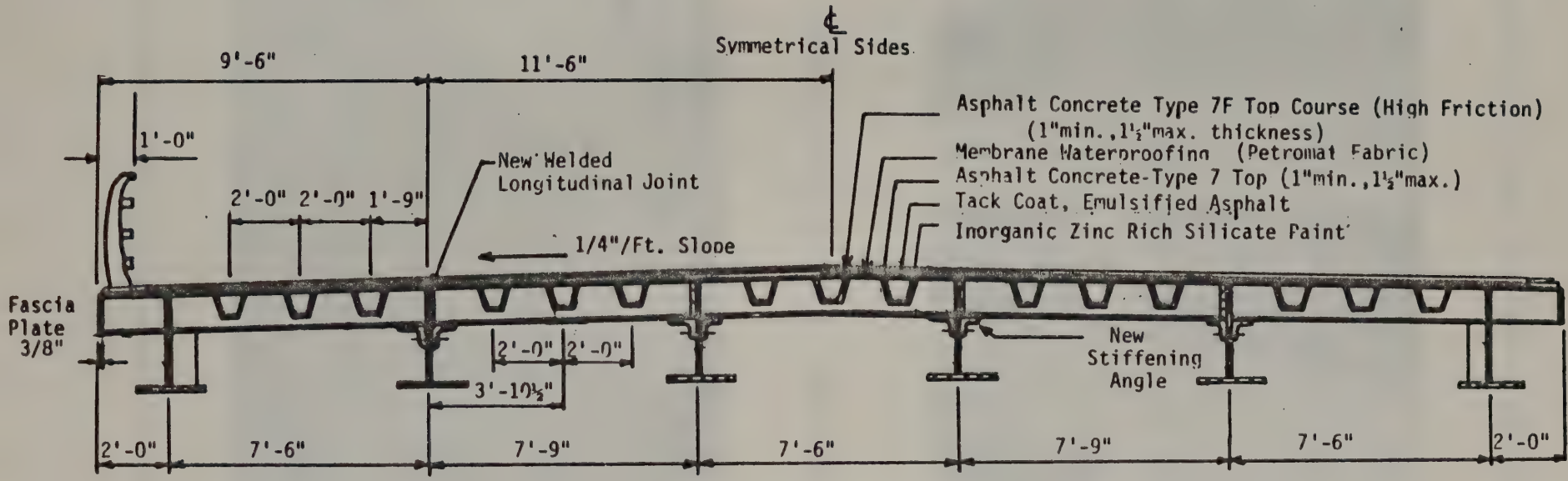

FIGURE 3 - TRANSVERSE SECTION OF REHABILITATED SOUTH BAY BRIDGE

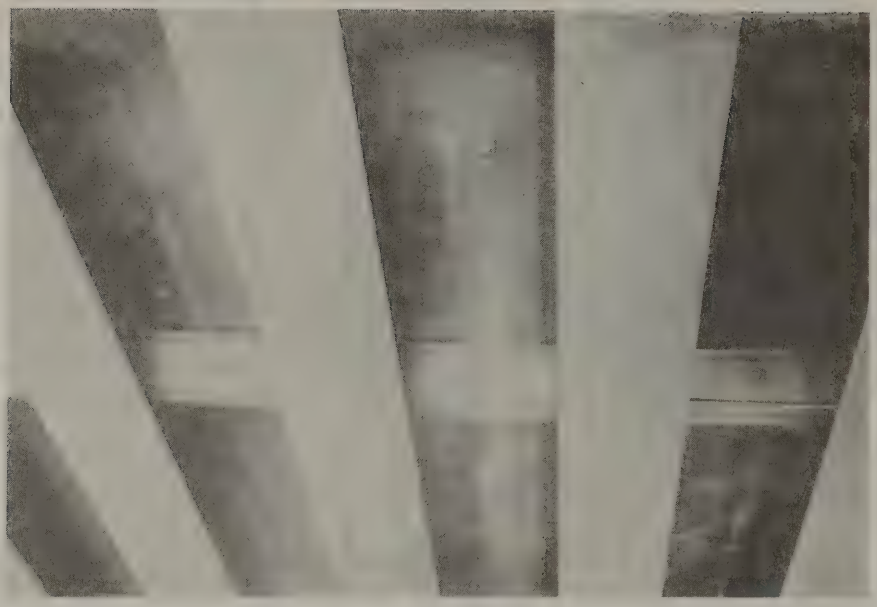

Figure 4. Underside of Webster Street Bridge.

Figure 5. Pavement Shoving on Webster Street Bridge Before Reconstruction.

The Webster Street Bridge was rehabilitated in 1981 under Contract No. D96775, P.I.N. 5940.03.303. Work consisted of removing the existing asphalt wearing surface and bituminous epoxy membrane and replacing it with an experimental wearing course system. This new system consisted of applying a proprietary preformed sheet waterproofing membrane and paving a 2 inch thick asphalt wearing surface. The proprietary membrane in this system was "Bituthene 5000" (formerly "Heavy Duty Bituthene"), as manufactured by W.R. Grace and Co., Cambridge, MA.

Figure 6 is a transverse section of the rehabilitated Webster Street Bridge. Appendix B contains the Contract Specifications and Notes relating to the work items.

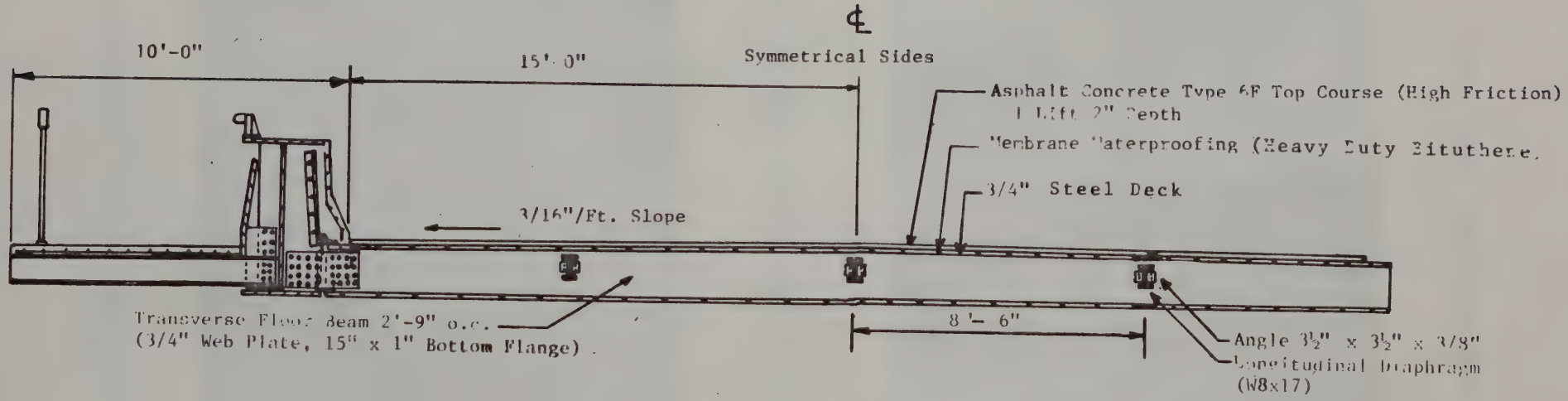

FIGURE 6 - TRANSVERSE SECTION OF REHABILITATED
WEBSTER STREET BRIDGE

III. RECONSTRUCTION WORK

1. South Bay Bridge

Rehabilitation work on the South Bay Bridge was conducted in two stages; work in the northbound lane began in May and was completed in August; work in the southbound lane began in August and was completed two months later in October, 1981.

Reconstruction consisted of removing the existing wearing course system; stiffening the steel plate deck sections; applying an inorganic zinc-rich silicate paint; and applying a fabric membrane and asphalt wearing surface. Each of these construction phases will be discussed separately.

a. Wearing Course Removal

Reconstruction work began with the removal of the existing bituminous concrete overlay and bituminous epoxy protective coating. Each was easily separated from the steel deck using a front end loader and limited hand work. The exposed steel was in good condition with the exception of the area at the edges of the steel deck plates. Minor rusting had occurred where the epoxy membrane and asphalt top course had cracked and allowed moisture to intrude.

b. Deck Plate Stiffening

To stiffen the deck and obtain continuity between abutting steel plates, stiffening angles were bolted and welded to the underside, at the location where each transverse floor beam intersected an interior girder. In addition, the longitudinal joints formed by adjoining steel deck plates were continuously welded. Originally, these sections were joined only by bolting through the web of each interior girder (Figure 7).

The welding procedure consisted of: commercial blast cleaning (SSPC-SP6) and air carbon-arc gouging to prepare the joint for welding; manual shielded metal-arc welding; and automatic submerged arc welding. Figure 8 is a transverse section illustrating the new construction, consisting of stiffening angles and the above mentioned welding. The detail shows stick welding of the approximately 1/8 inch gap at the longitudinal joint followed by seven or eight passes of the submerged arc welder to complete the joint.

c. Cleaning and Painting Steel Deck Plates

To protect the 7/16 inch thick steel deck plates from corrosion, a 2-3 dry mil thickness of inorganic zinc-rich silicate paint was applied. The paint chosen by the contractor was "Tneme-Zinc 90E-92." Surface preparation to remove rust and provide the appropriate anchor pattern consisted of near-white sandblasting (SSPC-SP10). Surface cleaning and painting operations were closely coordinated to prevent "flash rusting."

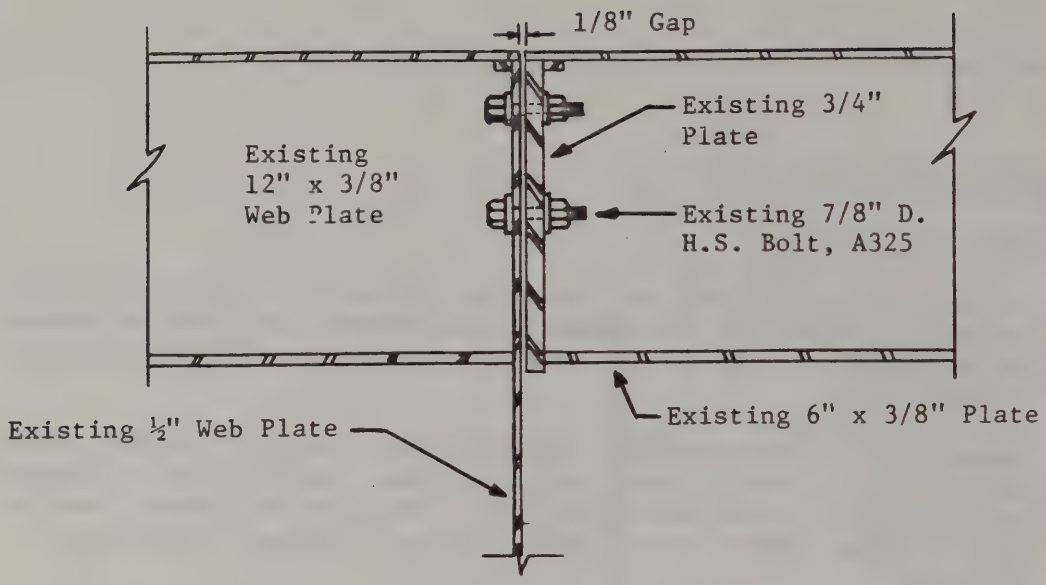

FIGURE 7 - TRANSVERSE DETAIL BEFORE STIFFENING

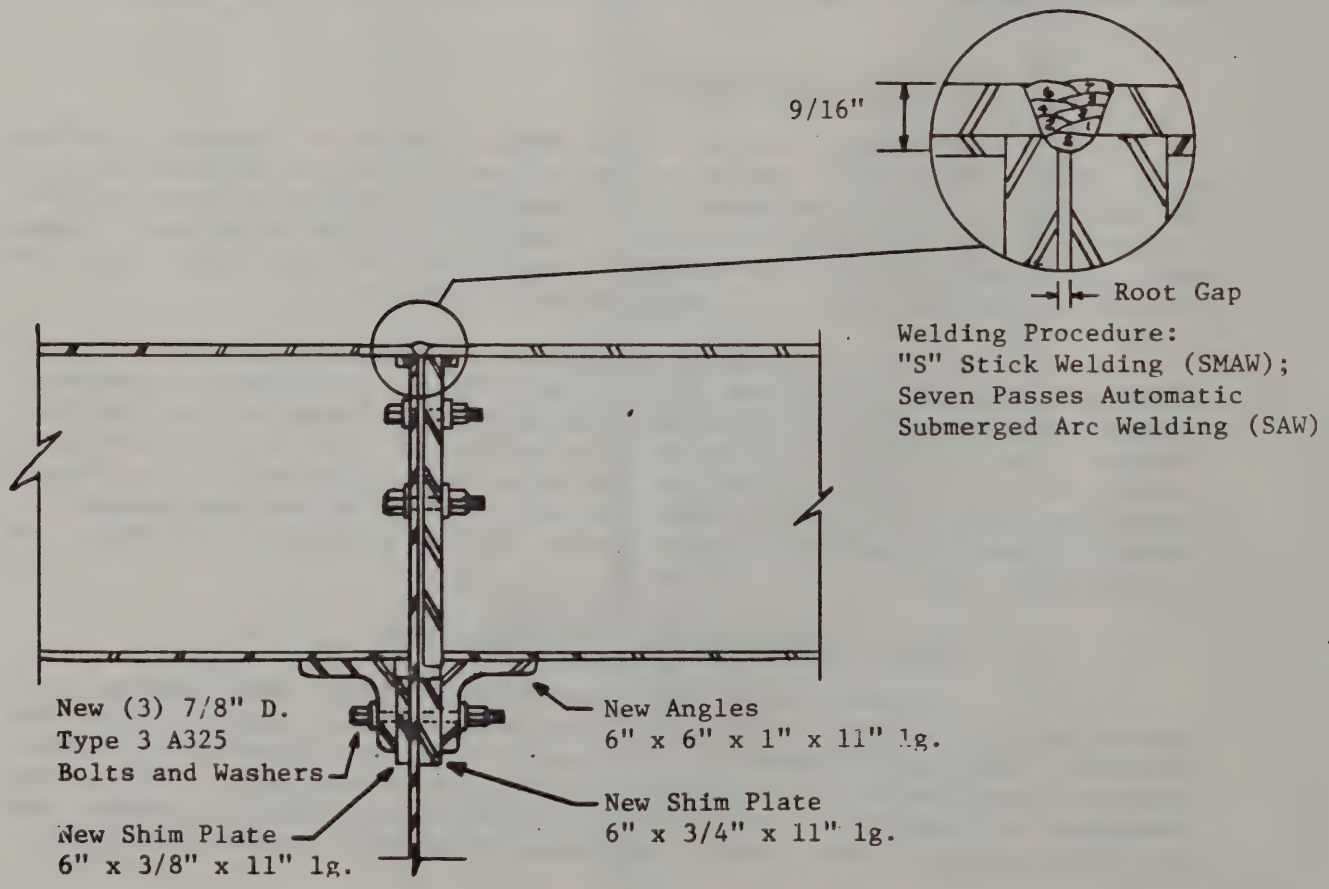

FIGURE 8 - TRANSVERSE DETAIL AFTER STIFFENING

At the start of painting work, a non-uniform color of the dried paint film was noted. Streaks of dark yellow (from the vehicle portion of the paint) were observed in what would normally be a greenish- gray coating . When lightly rubbed, these yellow streaks could be removed. Consultation with the paint manufacturer's representative indicated that a combination of inadequate agitation (mixing), faulty spray equipment, and steel deck surface temperatures exceeding the maximum recommended 120°F were the probable causes. To remedy this situation, new paint spraying and mixing equipment was obtained and painting work was confined to the cooler evening hours. This resolved the problem and work was performed without further delays.

d. Application of Wearing System

Before placing the first 1½ inch thick asphalt paving course, a fog coat of 140°F asphalt emulsion was applied. After curing, paving began and was completed the same day. Placement temperatures of the bituminous concrete averaged 295°F, which was within the allowable 250°-325°F temperature range.

The following day, "Petromat" fabric was placed on the first course paving mix. This fabric, when used in conjunction with an asphalt emulsion or asphalt cement, is intended to serve as a waterproofing membrane to protect the underlying substrate and to reduce cracking by acting as a reinforcement to distribute stress in the overlying bituminous concrete.

Application began by spraying a 310°F asphalt cement (AC-20) at the rate of .25 gal./sq. yd. On the advice of "Petromat's" technical representative, this rate was increased to .30 gal./sq. yd. Membrane application was performed manually (Figure 9) with the aid of push brooms to provide tension in the roll and to smooth out any wrinkles. To provide transverse drainage, longitudinal overlaps were shingled 6 to 12 inches; transverse overlaps were positioned to prevent pick-up by the paving equipment. The only problem encountered during this operation occurred during the second stage of rehabilitation in October. Cool weather conditions (50-55°F) prevented distributor truck spray application of the asphalt cement binder. Normally the distributor truck would spray binder one span (88 ft.) ahead of the membrane placement operation. In the cool weather the asphalt cement hardened prematurely, resulting in a tack-free surface which the "Petromat" could not absorb or adhere to. The ensuing hand spraying, only 10 to 15 feet ahead, left a tackier substrate for the membrane to be placed. This method was effective, but tended to create a heavy and non-uniform binder application.

Top course paving over the "Petromat" fabric was performed the following day. Mix temperature for this 1 inch thick lift was specified to range from 275° to 325°F. These temperature limits were included to insure an asphalt saturated "Petromat" fabric that would bond to the under and overlying bituminous concrete. No problems were encountered during this phase and the recorded mix placement temperatures ranged from 280° to 290°F.

Figure 9. Manual Application of Fabric Membrane.

2. Webster Street Bridge

This bridge was closed to traffic on July 6, 1981, when work began to remove the existing wearing surface and epoxy protective coating. This operation progressed smoothly and most of the bituminous epoxy protective coating was removed simultaneously with the overlay. The underlying 3/4 inch steel deck was in good condition with little or no evidence of corrosion.

Surface preparation of the steel deck consisted of commercial blast cleaning (SSPC-SP6). This degree of surface preparation was considered sufficient for application of the waterproofing membrane. Deck cleaning work was performed in close coordination with the membrane application to prevent "flash rusting."

"Bituthene 5000" (formerly "Heavy Duty Bituthene") waterproofing membrane was applied directly to the steel deck to protect it from corrosion. This pressure sensitive preformed sheet material was supplied in 3 foot wide by 60 foot long rolls. No primer, as normally used in conjunction with concrete deck applications, was used.

Membrane application started at each curb section (low point) and progressed toward the roadway centerline (Figure 10). This method provided a "shingling" effect for transverse water drainage. Longitudinal overlaps were 2 inches; transverse overlaps were 8 inches and also "shingled" to provide down-grade water run off. The membrane application was completed in two days (Figure 11).

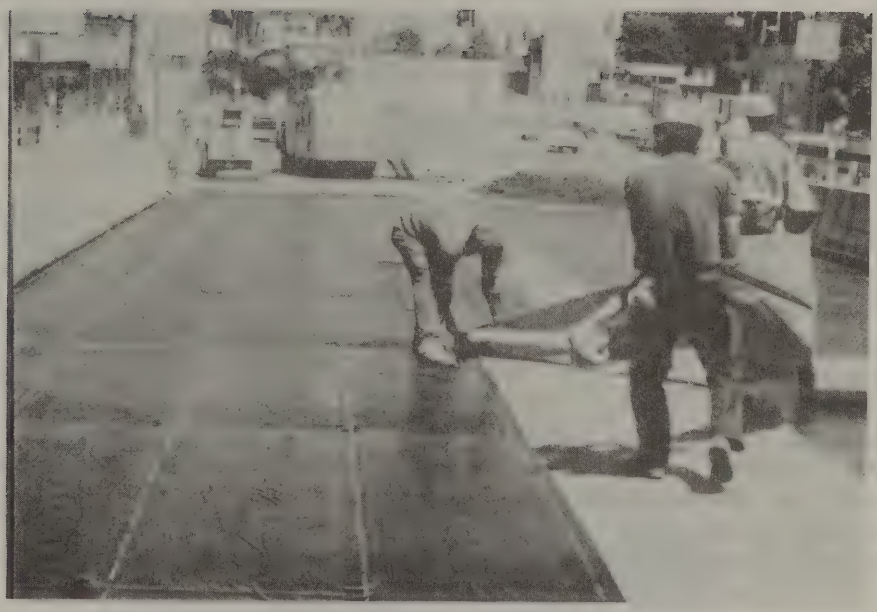

Figure 10. Membrane Waterproofing Application.

Figure 11. Completed Membrane Placement.

The two inch bituminous concrete overlay was a standard top course mix. Its gradation was different than that used on South Bay in that a slight amount of larger aggregate ($\geq$ 3/8 inch) was included to increase mix stability. This structure's profile has grades that approach four percent. Asphalt placement temperatures were modified to ensure good adhesion and to protect the membrane from damage. The specifications required a bituminous temperature range of between 275° and 310°F. Paving progressed up the steeper 3.8% grade and the mix temperatures ranged between 290° to 310°F. No damage to the membrane occurred during the paving operation.

Due to the original construction of the orthotropic superstructure, the asphalt thickness varied between 2" and 2 3/4". When the joints between adjoining steel deck plate sections were originally welded, the effect of high welding temperatures caused the steel to distort. The result was an undulating surface with a 3/4 inch difference in elevation between the welded joints and the center of the steel deck plate section. Asphalt compaction of this 2 3/4 inch thickness over the joints was performed without shoving. However, inspection of the completed wearing surface four hours after placement revealed "tender" areas at these locations. To avoid displacement of the asphalt wearing surface, the bridge was kept closed to traffic for two days after paving. All work was completed and the structure opened to traffic on July 17, 1981.

IV. PERFORMANCE EVALUATIONS

1. Whitehall Test Site (South Bay Bridge)

In May, 1982 this site was evaluated to determine its performance after one winter. Hairline (1/16±") cracks had developed at each of the stiffened joints over the four interior girders. These cracks extended longitudinally almost the entire length of each bridge span. The cracks did not appear detrimental and no further deterioration was noted.

Based on reports of more serious problems a second survey was made in August 1982, approximately 10 months after reconstruction was complete. The new wearing surface in the southbound traffic lane was disbonded and sliding over the steel deck plates. The worst distress was located at each expansion joint (Figure 12) but a general displacement of the asphalt had occurred within most of the southbound area. By contrast the northbound lane showed no or only minor evidence of distress. In some of the wheelpath area the asphalt had shoved laterally, resulting in a slight depression of the bituminous material (0 to 1/8").

Figure 12. Wearing Course Failure at South Bay

The failure mode in the southbound lanes was observed to be complete disbondment between the first bituminous concrete paving course and the zinc-rich painted steel deck. This occurred at each expansion joint and resulted in the entire wearing system sliding from 12 to 18 inches away from the north, trailing side of the joint header. The painted deck was completely exposed in this area and there was no visible evidence of the asphalt emulsion tack coat on the steel surface. Accompanying this disbondment, the southbound lane had shoved laterally across its entire 12 foot width. This was observed as tearing and cracks in the top (second) bituminous paving course and bulged areas at each edge of the travel lane. A stringline placed across the southbound lane showed a typical ½ to 1 inch depression of the bituminous material. It should be noted that at the time of failure the two components of this experimental system were observed to be in good condition; the zinc-rich paint was intact and the fabric membrane well adhered to the bituminous paving courses.

The bridge was inspected again in March, 1983. The northbound lane appeared satisfactory. There was no evidence that the minor shoving in the wheelpaths that was observed in the August, 1982 survey had progressed. The condition of the southbound lanes also appeared to be unchanged. The disbonded wearing surface at the transverse joints had been cut-out by maintenance forces, up to 3 feet from the joint header and patched with bituminous material. These asphalt patches were holding up well, but some additional disbondment of the experimental wearing system appeared to be occurring adjacent to the new asphalt material. This was evident as ¼ to ½ inch gaps between the new patch and wearing surface system.

2. Webster Street Test Site

This site was first surveyed in September, 1981, 1½ months after work was completed. Because of unusually warm weather in latter July and throughout August, there was concern that some early distress might occur. No shoving, cracking or similar defects were noted, but slight traces of asphalt bleeding were evident in the wheelpath areas, particularly on the 3.8% grade. Overall the wearing surface was in excellent condition.

A second survey was made in January, 1982. There was no evidence of deterioration in the wearing system except for some minor ravelling of the asphalt overlay in the wheelpath areas.

The most recent survey in June, 1983, approximately 2 years from the completion of construction, showed no evidence of deterioration and indicated that this system is performing satisfactorily.

V. DISCUSSION - SOUTH BAY BRIDGE WEARING SYSTEM

Investigation of Failure

A definite reason for the failure of the wearing system in the southbound travel lane at South Bay has not been determined. However, based on investigations and the comparable satisfactory performance of the northbound lane, placement of the southbound wearing system in the cooler weather conditions of October appears to be the primary cause of this problem.

Satisfactory performance of this system would be dependent on two factors; bond to the steel deck plates and density of the asphalt paving mix. To investigate these characteristics, cores were removed from both the north and southbound sides of the structure.

Bond of the wearing system would be provided by the asphalt emulsion tack coat. The cores taken from the northbound lane were all firmly adhered and had to be manually pried loose from the steel deck. Examination of the resulting core holes showed a well bonded and uniform coat of asphalt emulsion on the deck plates. All cores taken from the failing southbound lane were disbonded from the deck and simply lifted off the steel plates. Examination of these core holes revealed the zinc painted steel deck only - there was no evidence of the asphalt tack coat. It is believed that the asphalt emulsion failed to completely "break" in the cooler weather conditions, resulting in it not adhering to the steel, and therefore, not being capable of bonding the wearing system.

The second factor, pavement density, would be a function of the compactive effort produced by rolling at proper mix temperatures. Laboratory tests were conducted on the northbound and southbound cores to determine the effectiveness of the asphalt mix compaction. The results are reported below as the average percent air voids.

	Top Course	Bottom Course
Northbound	3.47%	5.58%
Southbound	10.53%	13.92%

It is evident from these results that both paving courses in the southbound lane had much higher air voids than the northbound side. The values given are significantly higher than the 4-8% air voids common in a field compacted mix of this type. As a result, it appears that inadequate mix compaction during cool weather resulted in an unstable mix and shoving.

To determine the best method to repair the deteriorated southbound lane, simulated laboratory shear tests were devised. These tests were designed to compare the bond strengths of the original and existing wearing course systems to the steel deck, at both the South Bay and Webster Street bridges.

The evaluation consisted of shear testing laboratory prepared samples of 1½ inch thick asphalt "paved" on the following substrates:

1. Sandblasted Steel Plates - These are intended to represent the deck on the South Bay Bridge. Although the existing deck plates are painted with a zinc-rich coating, the surface texture is not smooth and is similar to a blasted steel plate.

2. "Bituthene 5000" Waterproofing Membrane - To represent the wearing system on the Webster Street Bridge.

3. Bituminous Epoxy Membrane Coating (with coarse aggregate) - To represent the original wearing system on the South Bay Bridge. This system failed by cracking, due to excess flexibility of the deck, but shoving and sliding of the asphalt did not occur.

The results of these tests (Table 1) are reported as the horizontal load (lbs.) necessary to produce slip of the asphalt over its underlying substrate.

TABLE 1 - LABORATORY SHEAR TESTS

	HORIZONTAL LOAD REQUIRED TO PRODUCE SLIPPING (LBS.)			
	TEST NUMBER			
SYSTEM	1	2	3	AVERAGE
Sandblasted Plate	1740	1890	1520	1717
Bituthene 5000	900	600	640	713
Bituminous Epoxy*	2300	2250	-	2275

*Test values reported are those obtained during the design stage for the original construction of the South Bay and Webster Street Bridges.

The samples on "Bituthene 5000" showed the lowest resistance to shear, but in all three samples slip occurred within the preformed membrane itself. The bond of the membrane to the steel and the overlying asphalt was good with no failure evident in these shear planes.

The samples on the sandblasted plates showed a higher resistance to shear than those on the "Bituthene 5000." However, when testing was completed, the asphalt could be easily separated from the steel plates, indicating a weak bond.

The samples on bituminous epoxy had the highest resistance to shear. These results are based on earlier testing, conducted as part of the original bridge design and no comment on the visible condition of the samples after test can be made.

Recommendations for Repair

Based on the results of the investigation of the South Bay wearing system failure and the satisfactory performance of the wearing system on the Webster Street Bridge, it has been recommended that South Bay be repaired using the "Bituthene 5000" wearing course system. At the present time, a contract is being prepared to initate this work in the Summer, 1984.

VI. CONSTRUCTION COSTS

A listing of the construction items and their costs at South Bay and Webster Street is shown in Tables 2 and 3. Other incidental items not directly related to the placement of the wearing surface systems are not listed. The items in Table 2 for the Webster Street rehabilitation, specifically those regarding wearing system removal and steel deck cleaning, were bid on quantities much smaller (6,580 sq. ft.) than those at South Bay (22,420 sq. ft.). This factor may account for the high costs at Webster Street.

The final cost for the South Bay wearing system was $2.05/s.f., which included: deck surface preparation and painting; an asphalt emulsion tack coat; and a two course, 2½ inch, asphalt concrete overlay with the fabric membrane.

In comparision, the cost of the Webster Street system was $3.79/s.f. including: deck surface preparation; a waterproofing membrane; and an average 2½ inch thick bituminous concrete overlay.

TABLE 2. WEARING SURFACE SYSTEM COSTS-SOUTH BAY

ITEM NO.	DESCRIPTION	UNIT BID PRICE
581.01	Removal of Bituminous Concrete Overlay (Bridge)	$0.30 Per Sq. Ft.
16202.90	Removal of Existing Bit. Epoxy Membrane Waterproofing	$0.50 Per Sq. Ft.
16656.90	Structural Steel Reinforcement	$150.00 Each
16564.99	Cleaning and Welding Steel Orthotropic Bridge Deck Plates	$25.00 Per Lin. Ft.
16570.9901	Cleaning Structural Steel Orthotropic Bridge Deck Plate	$0.25 Per Sq. Ft.
16570.9902	Painting Structural Steel Orthotropic Bridge Deck Plate	$0.45 Per Sq. Ft.
407.01	Tack Coat-Emulsified Asphalt	$4.00 Per Gal.
403.18	Asphalt Concrete-Top Course Type 7	$55.00 Per Ton
16558.01	Membrane Waterproofing	$0.50 Per Sq. Ft.
18403.1911	Asphalt Concrete-Top Course (High Friction) - Type 7F	$55.00 Per Ton

TABLE 3. WEARING SURFACE SYSTEM COSTS-WEBSTER ST.

ITEM NO.	DESCRIPTION	UNIT BID PRICE
581.01	Removal of Bituminous (1) Concrete Overlay (Bridge)	$1.00 Per Sq. Ft.
05570.0320	Cleaning Structural Steel Orthotropic Bridge Deck	$2.00 Per Sq. Ft.
15558.50	Membrane Waterproofing System for Structural Slabs	$1.00 Per Sq. Ft.
18403.1711	Asphalt Concrete-Top Course (High Friction) - Type 6F	$50.00 Per Ton

(1) Item includes cost of removing existing bituminous epoxy membrane.

VII. FUTURE WORK

Future work on this project will consist of continued performance evaluations at the Webster Street test site with an interim report to be issued in 1985.

Rehabilitation work at the Whitehall test site (South Bay Bridge) will be monitored during the Summer, 1984, and will be reported under Experimental Feature Project NY 84-01, "Wearing Surface for Steel Orthotropic Bridge Deck."

APPENDIX A

SOUTH BAY - SPECIAL NOTES
AND SPECIAL SPECIFICATIONS

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SPECIAL NOTE

SECTION 407 - TACK COAT

Unless otherwise directed by the Engineer, surfaces painted with inorganic zinc-rich paint shall not be treated with the tack coat until a minimum of 120 curing hours have elapsed. For the definition of a curing hour, see the item: PAINTING STEEL ORTHOTROPIC BRIDGE DECK PLATE.

The bituminous tack coat shall be a "fog coat" uniformily applied to the zinc painted surface of the steel orthotropic bridge deck. To obtain the desired "fog coat" the approximate coverage rate shall be 0.05± gallons per square yard.

The "fog coat" shall be applied by hand, using methods and equipment approved by the Engineer. All necessary precautions shall be taken to prevent contamination of the underlying waterway and defacement of appurtenances at the time of application.

SPECIAL NOTE

PROTECTION AND OVERLAYING OF
FABRIC MEMBRANE WATERPROOFING SYSTEM

The asphalt concrete wearing course shall be placed on the fabric membrane waterproofing system preferably within eight(8) hours but not later than five(5) days after the placement of the membrane system. If more than twelve(12) hours elapse, the system shall be protected to the satisfaction of the Engineer.

The temperature of the bituminous paving material, at the time of placement, shall not be less than 275° F nor greater than 325° F.

On grades, bituminous paving equipment shall be operated in the "downhill" direction to minimize damage to the membrane.

Vehicular traffic directly on the membrane system shall be prohibited. Only that equipment necessary for transporting, placing, and compacting the overlay shall be allowed on the completed membrane system. Vehicles transporting the overlay material shall be rubber-tired and operated at slow speeds (not to exceed 5 m.p.h.). All vehicles shall avoid making sharp turns sudden starts and stops or other movements on the membrane that may cause breaks, lifting, or other damage. If vehicle tires cause pick-up of the membrane small quantities of tale, cement, or powdered limestone may be used to dust the tires.

Any damage to the waterproofing system during the overlay operation shall be repaired immediately according to the manufacturer's instruction. A quantity of repair material shall be kept on hand against such contingency. No additional payment will be made for any areas that require repairs.

Rain or other inclement weather conditions prior to overlaying may cause loss of bond and a blistered appearance throughout the fabric membrane waterproofing system. Should this condition occur it shall be corrected to the satisfaction of the Engineer, by pneumatic rolling until adhesion is restored. No additional payment will be made for this work.

ITEM NO. 16202.90 - REMOVAL OF EXISTING BITUMINOUS EPOXY MEMBRANE WATERPROOFING

DESCRIPTION:

This work shall consist of removing existing bituminous epoxy membrane waterproofing from the steel orthotropic bridge deck surface. The purpose of this work shall be to prepare the steel deck for subsequent cleaning, welding, and painting.

MATERIALS:

Any materials used in the removal of the bituminous epoxy membrane shall be as determined by the Contractor, except that they shall be approved by the Engineer prior to use and shall conform to any Local, State, or Federal law, regulation, or code.

CONSTRUCTION DETAILS:

The work required to remove the existing epoxy membrane may be performed in any manner, with the Engineer's prior approval.

The extent of work shall be such that all overlying (built-up) deposits of bituminous epoxy membrane are completely removed from the surface of the steel deck. It is not intended that minor deposits of epoxy remaining in the form of slight shadows or discolorations be removed under this item; nor that deposits of existing epoxy in cracks between abutting steel plates be removed.

No material, membrane, or cleaner shall be allowed to enter the lake water.

All existing bituminous epoxy membrane shall be removed and disposed of, in a manner acceptable to the Engineer.

METHOD OF MEASUREMENT:

The work shall be measured by the number of square feet of exposed deck plate, regardless of how or when the epoxy membrane was removed.

BASIS OF PAYMENT:

The unit price bid per square foot shall include the cost of furnishing all labor, materials, and equipment to satisfactorily complete the work.

SPECIAL SPECIFICATION

ITEM 16558.01 - MEMBRANE WATERPROOFING

DESCRIPTION:

This work shall consist of furnishing and installing a fabric membrane waterproofing system at the locations indicated on the Plans.

MATERIALS:

1. Fabric Membrane. The fabric membrane shall be "Petromat fabric" (5 oz./S.Y.), Bridge Deck Membrane Grade as manufactured by Phillips Fibers Corporation, Greenville, South Carolina 29602.

2. Bituminous Binder. Bituminous binder shall be asphalt cement conforming to the requirements of Materials Specification 702-03 (Viscosity Grade AC-20).

CONSTRUCTION DETAILS:

Work shall not begin until a minimum of 24 hours after placement of the first asphalt pavement course.

The fabric membrane waterproofing system shall be placed in accordance with the fabric membrane manufacturer's written instructions.

Work shall not be done during wet weather conditions nor when atmospheric conditions are such that unsatisfactory results will be produced. The Engineer shall be the sole determiner of favorable atmospheric conditions.

Distributor equipment for the application of bituminous binder shall conform to the requirements of Standard Specification Section 407-3.01 and shall be capable of heating and spreading the bituminous material at the specified temperature and application rate.

The fabric membrane shall be placed longitudinally on the bridge. It also shall be placed at lower elevations first with subsequent pieces being lapped to form a "shingle" effect.

All termination edges (longitudinal, transverse and vertical) at the fabric membrane waterproofing system shall be sealed with an asphalt mastic or other sealer recommended by the manufacturer, and approved by the Engineer.

The fabric membrane waterproofing system shall be placed in accordance with the written instructions of the manufacturer. Two (2) copies of the written instructions shall be submitted to the Materials Bureau and one (1) copy to the Engineer for approval, 21 days prior to the placement of the membrane. The instructions shall include specific application rates and temperature requirements for the bituminous binder.

SPECIAL SPECIFICATION

ITEM 16558.01 - MEMBRANE WATERPROOFING

METHOD OF MEASUREMENT:

The work shall be measured as the number of square feet of surface area of the bridge deck. No separate measurement for any vertical faces (joints, headers, scuppers, etc.) shall be made.

BASIS OF PAYMENT:

The unit price bid per square foot for this item shall include the cost of furnishing all labor, materials (including bituminous binder) and equipment necessary to complete the work. Any cost incurred for providing the fabric manufacturer's representative, shall also be included in this item.

No payment will be made for any work necessitated by damage or defacement attributable to the Contractor's operations.

SPECIAL SPECIFICATION

ITEM NO. 16564.99 -CLEANING AND WELDING STEEL ORTHOTROPIC BRIDGE DECK PLATES

Description. The work will consist of:

1. Cleaning a six (6") inch wide band of steel deck plate centered over each of four interior stringers.

2. Welding the longitudinal joints of the deck plates so a single, solid deck plate results.

Materials. Materials for cleaning shall be in accordance with the requirements of SSPC-SP6 - COMMERCIAL BLAST CLEANING. All materials shall conform to the applicable Federal, State, and Local laws, regulations, and codes.

Materials for welding shall conform to the requirements of the New York State Steel Construction Manual.

Construction Details. All equipment shall be approved by the Engineer prior to use.

The six (6") inch wide band along the deck joint shall be cleaned in accordance with the requirements of SSPC-SP6.

Material within the deck joint between plates shall be removed to a depth of 7/16" prior to welding. Method of removal will be subject to the Engineer's approval.

All welding shall be done in conformance with the New York State Steel Construction Manual.

Method of Measurement. The work will be measured as the number of linear feet of joint welded. Measurement will be taken along the centerline of weld.

Basis of Payment. The unit price bid per linear foot shall include the cost of all labor, materials, and equipment necessary to complete the work.

ITEM 16570.9901 - CLEANING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK PLATE

DESCRIPTION:

The work shall consist of cleaning the entire top surface of a steel orthotropic bridge deck to the cleanliness value known as Near White.

The work will be done by sandblast methods. The condition known as "flash rusting" will not be permitted to remain on the steel, should it occur.

MATERIALS:

Materials used for this work shall be as required by SSPC-SP10; Near White Blast Cleaning.

The abrasive used shall leave an anchor pattern which has a "maximum height of profile not in excess of 2.0 mils (0.002 inch). "Maximum height of profile is defined as the distance from the bottom of the lowest pits to the top of the highest peaks.

The specific type of abrasive which will produce the foregoing anchor pattern limit is given in the appendix of SSPC-SP10, or the information may be obtained from abrasive manufacturers.

All cleaning materials shall conform to applicable Federal, State and Local laws, regulations and codes.

CONSTRUCTION DETAILS:

Structural steel deck plate (including longitudinal welds) shall be cleaned in accordance with the requirements of SSPC-SP10, to the anchor pattern limits described in MATERIALS.

The surface, after cleaning, shall be as defined by ASTM D2200, SSPC Vis1, Pictorial Standards ASz2½, BSa2½, CSa2½, or DSa2½, as applicable.

All blasting products, and residue, shall be removed by air blowing, or vacuum cleaning, prior to the application of paint.

"Flash rusting", if it occurs, will not be permitted to remain. All surface areas exhibiting "flash rust" shall be recleaned in accordance with SSPC-SP10, at no additional cost. Close coordination with the work of the item titled PAINTING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK PLATE is advised.

METHOD OF MEASUREMENT:

The work will be measured as the number of square feet of surface area cleaned. The quantity measured for payment shall not exceed the estimated quantity indicated on the plans. Field measurements will be taken only to provide progress payments.

BASIS OF PAYMENT:

The unit price bid per square foot shall include the cost of all labor, materials and equipment necessary to complete the work.

Progress payments will be made for no more than 60% of the estimated area.

ITEM 16570.9902 - PAINTING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK PLATE

DESCRIPTION:

The work shall consist of painting the entire top surface of a steel orthotropic bridge deck plate with an inorganic zinc-rich coating.

The work of this item should be closely coordinated with the work of the item titled: CLEANING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK PLATE.

MATERIALS:

Paint. This may be any one of the following:

1. "Carbo Zinc 11" as manufactured by Carboline, St. Louis, MO 63114.

2. "Dimetcote 4 Protective Coating" as manufactured by Ameron, Protective Coatings Division, Brea, California 92621.

3. "90E-92 Tneme - Zinc" as manufactured by Tnemec Company, Inc., Kansas City, MO 64141.

4. Inorganic zinc silicate conforming to the requirements of Military Specification M1L-P-23236 (SHIPS), Type I, or Type II, Class 3.

Only one manufacturer's paint will be allowed to coat the steel surface. Once painting operations have begun no paint substitutions will be permitted.

Packaging and Shipment. Paint shall be shipped in strong, substantial containers and tightly sealed in accordance with commercially accepted standards. Each container shall be plainly marked with:

1. Product name.
2. Weight and volume.
3. Instructions for use.
4. Date of manufacture.
5. Date of expiration, or shelf life time.
6. Name and address of manufacturer.
7. Military specification number, type, and class, if applicable.

Basis of Acceptance.

1. Specific products previously listed will be accepted based on the required container markings.

2. Paint supplied as meeting military specification M1L-P-23236, shall be approved by the Director, Materials Bureau.

   The manufacturer of this paint shall submit;

   a. Certification that the paint conforms to Military Specification M1L-P-23236, Type I or Type II, Class 3.

   and

   b. Independent laboratory certified test results as evidence that he

has previously formulated paint in accordance with M1L-P-23236, Type I or Type II, Class 3. These test results do not have to represent production batches of paint supplied for this work.

The Director, Materials Bureau will require 20 working days to render a decision. The 20 working days will be measured from the date of receipt of all pertinent information required.

CONSTRUCTION DETAILS:

The requirements of subsection 740-01 shall apply, with the following modifications:

1. No paint shall be applied to any surface which does not meet the definition of ASTM D2200, SSPC Vis1, Pictorial Standard ASa2½, BSa2½, CSa2½, or DSa2½, as applicable.

2. No thinning of paint shall be allowed unless the manufacturer's instructions specifically require thinning for the proper application of the material. If so required, only the specific solvents noted, and in the amounts recommended, by the manufacturer, will be allowed.

3. Paint shall be mixed in accordance with the manufacturer's instruction. Also, at the time of application continuous agitation will be required to maintain zinc particles in suspension.

4. Paint shall be applied within eight hours of the cleaning of the deck plate. Paint shall not be applied to any area which exhibits "flash rust", or blast cleaning operation residue. Close coordination with the work of the item: CLEANING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK PLATE, is advised.

5. All weld areas, bolt heads and all edges of steel plates and shapes shall be "striped" with one coat of paint prior to the painting of the steel deck plate.

6. Paint shall be applied to the steel deck plate at a rate which will result in a dry film thickness of 2.0 to 3.0 mils (0.002 to 0.003 inch). Areas which have been "striped" may be painted over while still wet.

7. After application, the paint shall dry for a minimum of 120 curing hours. A curing hour is defined as an hour during which the temperature is 40°F. or higher, and the humidity is 85%, or less.

8. Paint applications shall be protected from rain, or other natural hazards, with methods approved by the Engineer, until the required number of curing hours have passed.

9. After curing has been completed, the Engineer will verify the required dry film thickness. Any areas which exhibit less than that required will be recoated, and cured, in accordance with this specification at no cost to the State.

Page Three - PAINTING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK PLATE

METHOD OF MEASUREMENT:

The work will be measured as the number of square feet of surface area painted. The quantity measured for payment shall not exceed the estimated quantity indicated on the plans. No measurement will be made for areas "striped" prior to the steel deck plate painting. Field measurements will be taken only to provide progress payments.

BASIS OF PAYMENT:

The unit price bid per square foot shall include the cost of all labor, material and equipment necessary to complete the work.

No extra payment will be made for advance "striping".

No payment will be made for recoating necessitated by a dry film thickness thinner than that required.

Progress payments will be made for no more than 60% of the estimated area.

SPECIAL SPECIFICATION

ITEM NO. 16656.90 - STRUCTURAL STEEL REINFORCEMENT

DESCRIPTION:

The work shall consist of installing primed stiffening angles and primed shim plates at the locations indicated on the Contract Plans. All work shall be done in a manner satisfactory to the Engineer.

MATERIALS:

Materials required for this work shall meet the following requirements:

1. Welding - New York State Steel Construction Manual - Section 203.

2. Bolts, Nuts, and Washers - ASTM A325, Type 3.

3. Shim Plates and Angles - ASTM A36.

4. Painting - Subsection 740.01, Painting, (B.)
   Shop Painting of the Standard Specifications.

CONSTRUCTION DETAILS:

The shim plates and angles shall be delivered shop primed according to the Materials Section above.

All work shall be done in conformance with the New York State Steel Construction Manual.

METHOD OF MEASUREMENT:

The work will be measured as each location reinforced.

BASIS OF PAYMENT:

The price bid for each location reinforced shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work.

APPENDIX B

WEBSTER STREET - SPECIAL NOTES
AND SPECIAL SPECIFICATIONS

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P. I. N. 5940.03.303
Rehabilitation of Orthotropic Deck

SPECIAL NOTE

ITEM 15558.50 - MEMBRANE WATERPROOFING SYSTEM FOR STRUCTURAL SLABS

The requirements of Item 15558.50 shall apply, except for the following modifications:

1. Whenever "structural slab" is referred to it shall be interpreted as "structural steel orthotropic bridge deck plate".

2. The membrane waterproofing material on this project shall be the Bituthene Preformed System. No substitution of another system shall be allowed.

3. Prior to the application of the Bituthene Preformed System the steel orthotropic bridge deck plate and abutting vertical steel and concrete surfaces shall be cleaned. To reduce the possibility of "flash rusting" of steel surfaces close coordination between the work under this and the item entitled, cleaning Structural Steel Orthotropic Bridge Deck Plate, is advised. If approved by the Engineer, cleaning and waterproofing application work may be performed as simultaneous operations. When work is completed in this manner special care shall be taken to insure no blasting products or foreign materials are present on surfaces receiving the waterproofing membrane.

4. Primer shall not be applied to the steel surface of the orthotropic bridge deck plates or any abutting vertical steel surfaces. Primer shall only be applied to abutting vertical concrete surfaces and only to a height that will be one inch higher than the height of the completed asphalt overlay.

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P. I. N. 5940.03.303
Rehabilitation of Orthotropic Deck

SPECIAL NOTE

PROTECTION AND OVERLAYING OF
MEMBRANE WATERPROOFING SYSTEM (ITEM 15558.50)

The bituminous concrete overlay shall be placed on the membrane waterproofing system preferably within 24 hours but not later than seven (7) days after the placement of the membrane system.

The temperature of the bituminous paving material, at the time of placement, shall not be less than 275°F nor greater than 310°F. Bituminous material that is supplied, or allowed to cool to less than 275°F. prior to paving shall be rejected.

On grades, bituminous paving equipment shall be operated in the "downhill" direction to minimize damage to the membrane.

Vehicular traffic directly on the membrane system shall be prohibited. Only that equipment necessary for transporting, placing and compacting the overlay shall be allowed on the completed membrane system. Vehicles transporting the overlay material shall be rubber-tired and operated at slow speeds (not to exceed 5 M.P.H.). All vehicles shall avoid making sharp turns, sudden starts and stops, or other movements on the membrane that may cause breaks, lifting, or other damage. If vehicle tires cause pick-up of the membrane small quantities of talc, cement or powdered limestone may be used to dust the tires.

Any damage to the waterproofing system during the overlay operation shall be repaired immediately and prior to the placement of bituminous concrete. A quantity of material shall be kept on hand against such contingency. No additional payment will be made for any areas that require repairs.

Blisters that may raise during the overlay operation shall be vented to insure adhesion of the overlay to the membrane system. Blistered area will be most noticeable during the rolling operation. Venting shall be done by inserting an icepick or other suitable instrument into the affected area. These vent holes need not be repaired.

ITEM 15558.50 - MEMBRANE WATERPROOFING SYSTEM FOR STRUCTURAL SLABS

DESCRIPTION. This work shall consist of furnishing and applying a membrane waterproofing system where indicated on the Contract Plans. The work shall include the preparation of concrete surfaces. The Contractor shall select, furnish, and apply one of the membrane waterproofing systems included in this specification on each structure designated to receive Membrane Waterproofing System for Structural Slabs.

The Contractor has the option of using any one of the membrane waterproofing systems included in this specification, as desired. Also, substitution of one system for another may be done at will. However, only a single system may be used on any one structure, regardless of the length or design of that structure. No system may be substituted for any system which is already in any stage of installation.

MATERIALS.

Membrane Waterproofing System. The membrane waterproofing shall be either a preformed sheet or liquid system. The membrane waterproofing system shall consist of one of the proprietary sheet systems plus wire mesh or one of the proprietary liquid systems plus a protective sheet and wire mesh. No substitutions of the proprietary portions of the applied system shall be allowed.

Membrane Waterproofing Materials. The membrane waterproofing shall be one of the following:

A. PREFORMED SHEET MEMBRANE MATERIALS

1. Bituthene Preformed System - shall consist of Bituthene Primer, Heavy Duty Bituthene Membrane, and Bituthene Mastic; all as manufactured by W. R. Grace and Company, Cambridge, Massachusetts.

2. Protecto-Wrap Preformed System - shall consist of Protecto-Wrap No. 80 Primer, Protecto-Wrap M-400A Membrane, and Protecto-Wrap 160H Mastic; all as manufactured by Protecto-Wrap Company, Denver, Colorado.

3. Royston Preformed System - shall consist of Royston Bridge Membrane No. 10-A, Royston Bridge Membrane Primer 713-A; and Royston Roskote A-51 Black Mastic; all as manufactured by Royston Laboratories, Inc., Pittsburgh, Pennsylvania.

B. LIQUID MEMBRANE MATERIALS

1. POSH, HT Liquid System - shall consist of NEA 4000 HT; as manufactured by POSH Chemical, Inc., Port Washington, New York.

2. Superior, HT Liquid System - shall consist of Superseal 4000 HT; as manufactured by Superior Products Company, Oakland, California.

3. Watson-Bowman, HT Liquid System - shall consist of WABO-4000 HT; as manufactured by Watson-Bowman Associates, Inc., Buffalo, New York.

NOTE:

Containers of liquid waterproofing material shall be stored on the work site in such a manner as to prevent their exposure to direct sunlight and to temperature exceeding 100° F.

Protective Sheet. The protective sheet shall be smooth-surfaced asphalt roll roofing meeting the requirements of ASTM D224, Type II.

Wire Mesh. Wire mesh for use over subdrainage openings shall be 1/4-inch mesh, 23 gauge hot-dipped galvanized cloth.

CONSTRUCTION DETAILS.

General. Work shall not begin on existing structural slabs until seven (7) days have passed subsequent to the placement of portland cement concrete, portland cement mortar or epoxy mortar for structural slab repair. The Engineer may waive the seven day requirement if the areas of repair can sustain loads without damage or deformation. There are various other types of concrete repair materials which have different required periods of waiting prior to safe loading. If one of these is used, the Manufacturer's instructions for allowable loading shall be followed subject to the concurrence of the Engineer.

On new structural slabs, the provisions of § 555-3.09B, Minimum Curing Period for Loading Structural Slabs, shall be met prior to membrane system placement.

Work shall not be done during wet weather conditions nor when atmospheric conditions are such that unsatisfactory results will be produced. The Engineer shall be the sole determiner of favorable atmospheric conditions. No work shall be done when the concrete structural slab surface temperature is below 50°F, or ambient temperatures are below 50°F. The concrete structural slab shall be surface dry at the time of application of the membrane waterproofing system.

Structural Slab Cleaning. All structural slab surfaces and any other surfaces against which the membrane waterproofing system is to be placed shall be cleaned as follows:

1. All loose material, including dirt, gravel, and concrete laitance shall be removed by vacuuming or blowing with compressed air.

2. Any excess laitance (surface film of concrete), road oil, other bituminous-based materials, previous membrane treatments, and other foreign materials, including concrete curing compounds, shall be removed by sandblasting or wire brushing and washing with water or a combination of these methods. To confirm the adequacy of the cleaning, small test patches of primer and membrane shall be applied to any area(s) in question. These test patches shall then be evaluated by the Engineer. The Engineer may order additional cleaning where poor adhesion is found.

3. Immediately prior to application of the membrane system, surfaces to be coated shall be recleaned of dust and other loose material by vacuuming or blowing with compressed air.

Application of Preformed Sheet Membrane Systems.

A. Primer Application. After cleaning, all surfaces to be waterproofed shall be primed with the primer required for the selected preformed system. The primer shall be thoroughly mixed prior to application. Mixing shall be done with mechanical mixers or by hand mixing using clean paddles or other suitable instruments. Hand mixing shall be required for the Royston Prim.

The primer shall be applied, without dilution, using brushes, squeegees, rollers, or a combination of these methods. Spray application of the primer shall not be allowed. The primer shall be applied at the rate given in the following table so as to thoroughly and uniformly cover the surface. Areas of concrete which are porous and appear dry shall be given a second coat of primer.

Membrane System	Primer Application Rate
Bituthene System	200-400 sq.ft./gal.
Protecto-Wrap System	80-150 sq.ft./gal.
Royston System	Approx. 110 sq.ft./gal.

On vertical curb, concrete barrier, and header surfaces, the primer shall be applied and finished off, in a neat line, to a height that will be one inch higher than the height of the completed asphalt overlay. The outside face of metal scuppers shall not be primed. The inside surfaces of subdrainage outlets (weep tubes) shall be primed to a depth of at least 3 inches.

The primer shall be allowed to dry to a "tack free" condition prior to application of the preformed membrane. Excess primer, occurring as puddles or wet areas, shall be removed by brushes, or as directed by the Engineer. The appearance of bubbles in the primer is normal, due to outgassing of air and moisture in the concrete. After the primer has dried to a "tack free" condition, these bubbles shall be broken with squeegees or brooms. Unless otherwise directed by the Engineer, it shall not be necessary to repair the areas where bubbles have been broken.

Primed surfaces which the Engineer determines have become contaminated by dust or dirt shall be reprimed. Primed areas which have not been covered with preformed membrane within 24 hours of primer application shall be reprimed. All such repriming work shall be done at no additional cost to the State.

B. Preformed Sheet Membrane Installation.

1. General. The preformed membrane sheets and "flashing strips" shall be placed longitudinally on the structural slab so that both the longitudinal and transverse overlaps are formed in the direction of water drainage (See Plates 1, 2, and 3). "Flashing strips" shall be defined to mean sections of membrane which are used to waterproof vertical surfaces and seal the intersection of the vertical surface with the structural slab. At those locations where no cross slope exists on the structural slab, the transverse water drainage shall be assumed to be from the center of the roadway toward the curbs (See Plate 1).

Rolls of preformed sheet membrane may be applied by hand or mechanical means. The sheet shall be placed on the structural slab, sticky side down. Preformed sheet membrane flashing strips shall be placed and turned up the vertical faces of curbs, headers, scuppers, joints, and concrete barriers to a height equal to the thickness of bituminous overlay. Rolls of sheet membrane shall be placed in such a manner as to minimize wrinkles and bubbles. Stiff bristled brooms shall be used at the time of application to smooth the sheet at its point of contact with the structural slab. Unless otherwise noted herein, adjacent rolls of sheet shall overlap a minimum of 2 inches on transverse laps and 8 inches on longitudinal laps.

The application of the sheet membrane shall proceed as follows:

a. Before the rolls of sheet membrane are applied to the slab, flashing strips shall be applied to the vertical faces where the direction of water drainage is toward the vertical face. The "flashing strips" shall be placed so that their overlaps are formed in the direction of water drainage. The flashing strips shall extend up the vertical face to the depth of the bituminous overlay and a minimum of 6 inches onto the structural slab. Where required, the vertical faces shall be coated with mastic to ensure adhesion of the flashing strip (See Plate 4).

b. At subdrainage openings (weeps), mastic shall be applied to that area of the structural slab within 6 inches of the drain opening.

c. Rolls of preformed sheet membrane shall then be aligned parallel to and applied on the structural slab. The preformed sheet shall be placed within one inch of abutting vertical faces. At subdrainage openings, the membrane shall be pierced and the edges turned down and adhered to the inside of the drain. If necessary, mastic shall be used to ensure adhesion and to prevent seepage under the membrane (See Plate 4).

d. After the rolls of sheet membrane have been applied to the slab, flashing strips shall be applied to the vertical faces where the direction of water drainage is away from the vertical face, so the flashing strip is on top of the sheet membrane.

e. The vertical termination of the flashing strips shall be sealed with a bead of mastic (See Plate 4). The completed membrane shall be free of large wrinkles, "fishmouths", air bubbles, and other placement defects. These shall be corrected in a manner satisfactory to the Engineer. Where patches are used, the area shall be coated with mastic sealer and pieces of membrane pressed into the sealer over the defective area. The patches shall extend at least 6 inches in every direction beyond the edge of the defect. Bubbles of one inch diameter and greater shall be vented by piercing with an ice pick, or other suitable instrument, and expelling the air. Vented bubbles need not be repaired.

To insure adhesion to the structural slab, the preformed membrane shall be rolled with the required roller. Laps which have not been thoroughly sealed by rolling operations shall be sealed with mastic.

A 5-inch square piece of wire mesh shall be pressed into mastic applied to the membrane at each subdrainage opening.

When only a portion of the membrane application is completed in one day, the exposed edge of the membrane shall be sealed with mastic. The termination edge of the membrane at slab ends and expansion joints constructed without headers shall be sealed with mastic sealer.

2. Bituthene System. Rolls of preformed membrane shall be placed on the structural slab, sticky side down, by removing the release paper as the work progresses. The membrane shall not be stretched or otherwise placed in tension during the installation.

   On granite and other rough vertical faces, mastic shall be applied to the vertical face to ensure bonding of the flashing strips.

   Rolling shall be done with a 100-200 lb hand roller.

3. Protecto-Wrap System. Rolls of preformed membrane shall be placed on the structural slab, sticky side down. To minimize wrinkles and bubbles, the rolls of membrane shall be stretched into place. The membrane is interwound with polyethylene release film on the top surface. Except for the perforated edge strip, the film shall be left-in-place until the day the bituminous overlay is placed. The perforated edge strip of the polyethylene film shall be removed at the time of placement of an overlapping roll of membrane. Spliced rolls of membrane have release film on the bottom (sticky) side, so care shall be taken to ensure removal of the release film from spliced areas at the time of membrane application.

   All vertical surfaces shall be coated with mastic, to the depth of the asphalt overlay, before placement of the flashing strips.

   Rolling shall be done with a pneumatic tired roller.

4. Royston System. Rolls of membrane shall be placed on the structural slab, sticky side down, by removing the release paper as the work progresses. The polyester film on the surface of the membrane need not be removed.

Adjacent rolls of sheet shall overlap a minimum of 4 inches on transverse laps. End laps shall be sealed by heating the membrane surface to be covered with a propane torch, melting the polyester film and fusing the melted surface to the underside of the covering roll.

Flashing strips shall be adhered to vertical surfaces by the heat-fusion method: by heating the sticky side of the membrane and pressing the heated surface into contact with the vertical face. The heat-fusion method shall be used to adhere the membrane to the inside of subdrainage outlets.

Mastic shall not be used to adhere the flashing strips to the membrane sheets.

Rolling shall be done with a 100-200 lb hand roller.

4. Wrinkles in the membrane may be repaired by slitting the membrane and heat-fusing the overlapping pieces. Mastic shall be used to seal the edges of the repair areas.

Liquid Membrane Installation.

A. Membrane Heating Equipment. Heating vessels shall be double-boiler, indirect-fired or oil-bath melter-application type kettles. Heating with direct flame shall not be allowed. Heating equipment shall be inspected and approved by the Engineer prior to use.

B. Application Temperature. The application temperature range for the NEA 4000 HT, Superseal 4000 HT and WABO 4000 HT is 350°F to 400°F with a suggested application temperature of 375°F.

C. Liquid Membrane Application. The liquid membrane waterproofing material as supplied in its container is ready for pouring into the heating vessel. When the proper application temperature has been attained, the hot liquid material shall be poured directly onto the structural slab and spread at the specified application rate using squeegees. Brushes and rollers may be used to supplement the squeegee operation. The liquid waterproofing shall be applied at a rate of 17.8-19.3 square feet per gallon (wet film thickness of 83-90 mils). Control of the application rate is best achieved by applying measured volumes of the hot waterproofing material to measured areas of the structural slab. Excessive membrane thickness (greater than 90 mils wet film) shall be avoided to prevent subsequent problems in placement and compaction of the wearing course. The Contractor shall remove and replace, at no cost to the State, any areas of excessive membr thickness greater than one square foot.

The vertical faces of curbs, headers, and scuppers shall be coated with hot liquid waterproofing and finished off in a neat line, to a height that will be at least 1 inch higher than the height of bituminous overlay. If necessary on the vertical face multi-coat applications shall be made to obtain the required film thickness (83 mils wet film, min.).

The inside surfaces of sub-drainage outlets (weep tubes) shall be coated with hot liquid waterproofing to a depth of at least 1 inch. Immediately after placement of the waterproofing material, 5-inch square pieces of wire mesh shall be pressed into the wet coat of waterproofing over each sub-drainage opening (See Plate 5).

The completed coat of waterproofing shall be free of large pinholes, craters, and other placement defects. Pinholes and craters of 1/8 inch diameter and greater shall be corrected by "touching" up with hot liquid material or sealing with pre-cured pieces of liquid waterproofing.

Pre-cured patch material is made by applying the hot liquid to a smooth, impervious surface (the lid or top of the waterproofing container is suitable) and allowing it to cure in a sheet form. Pieces of this sticky sheet may then be used to plug holes or patch the liquid membrane.

Throughout the duration of work, the Contractor shall protect all exposed areas of curbs, sidewalks, railings, and other bridge appurtenances. Any damage or defacement resulting from the application of the liquid waterproofing shall be repaired to the satisfaction of the Engineer, at no cost to the State.

D. Protective Sheet Installation.

The hot applied liquid waterproofing will cure to a firm film within several minutes. The surface of the cured membrane will remain in a tacky or sticky condition. The protective sheet is to be applied directly to the sticky surface within one (1) hour of the application of the liquid membrane.

The protective sheet shall be placed over all of the structural slab surface, except that it shall not be placed on vertical surfaces. At subdrainage outlets, holes equal in size to the outlet opening shall be cut in the protective sheet. The protective sheet shall not be placed in, or otherwise adhered, to the inside surfaces of subdrainage outlets.

The protective sheet shall be laid flat, without the necessity of adhesives, on dry membrane surfaces (no visible moisture). Rolls or sections of protective sheet shall be set in place by butting against the edges and ends of adjacent sheets. Gaps of up to ¼ inch between sheets are allowable. Overlapping of the protective sheet shall not be allowed.

The complete protective sheet shall be free of wrinkles, "fishmouths", entrapped air bubbles, and other defects. Wrinkles and "fishmouths" shall be slit with a knife and laid flat. Entrapped air shall be removed by piercing the protective sheet with an ice pick or other suitable instrument. Care shall be taken not to puncture the underlying membrane.

After all placement defects have been corrected, the entire surface of the structural slab shall be rolled with a 100-200 lb hand roller. If, after rolling, additional air bubbles, or other defects, are evident, they shall be corrected in the manner previously noted.

When the placement and rolling of the roofing paper is complete, a bead of hot liquid membrane material shall be run along the intersection where the vertical faces of curbs, headers, and scuppers meet the roofing paper. The bead shall be placed such that void between the roofing paper and applied membrane is filled with membrane material to prevent the intrusion of water. (See Plate 5).

NOTE: To prevent the possibility of moisture entrapment beneath the protection sheet, the membrane waterproofing system should be overlayed as soon as possible after the placement of the roofing paper. If the protective sheet is exposed to rain or other forms of precipitation, it shall be re-rolled to remove any moisture which may have accumulated beneath the surface. If excessive wetness and pockets of moisture remain, the defective areas shall be vented or replaced, as directed by the Engineer.

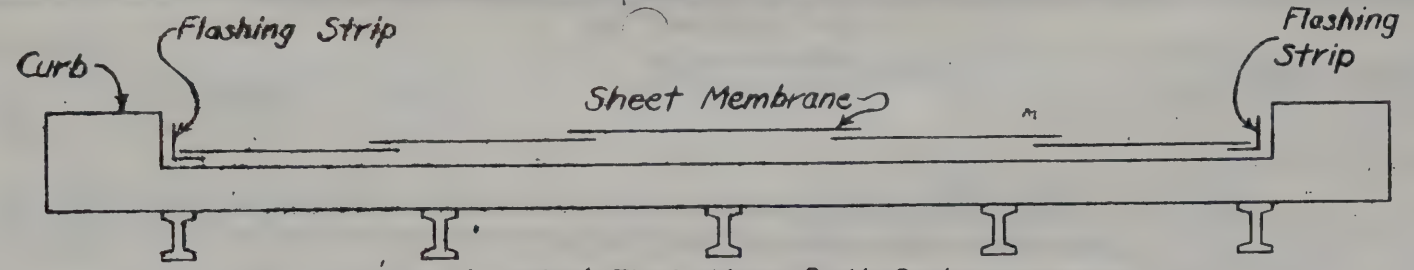
ITEM 15558.50 – MEMBRANE WATERPROOFING SYSTEM FOR STRUCTURAL SLABS -8-

METHOD OF MEASUREMENT. The work shall be measured as the number of square feet of surface area of the structural slab as shown on the plans covered with the complete membrane waterproofing system. No separate measurement of the vertical faces of curbs, joints, concrete barriers, headers, and scuppers, or for the inside surfaces of subdrainage outlets, shall be made. No deductions will be made for holes less than one square foot in area.

BASIS OF PAYMENT. The unit price bid per square foot for this item shall include the cost of furnishing all labor, materials, (including wire mesh), and equipment necessary to complete the work.

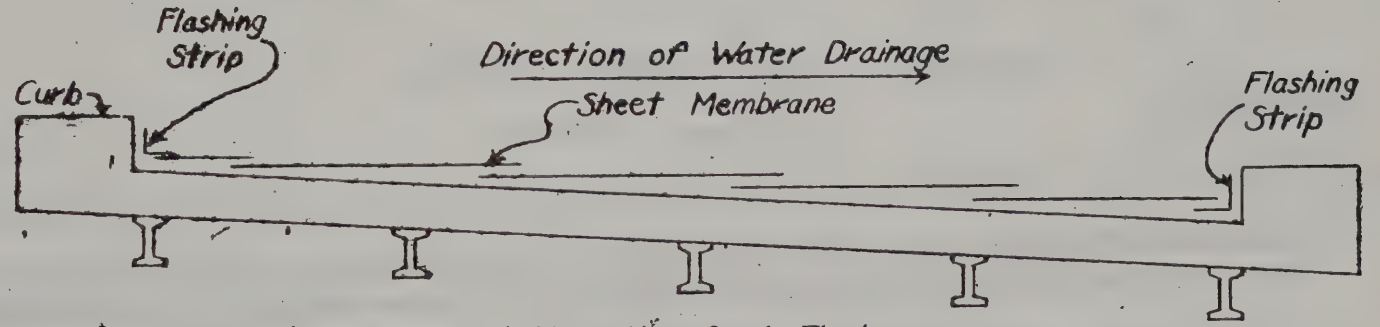
No payment will be made for any work necessitated by damage or defacement attributable to the Contractor's operations.

No additional payment will be made for any repriming done in conformance with the requirements of Application of Preformed Sheet Membrane Systems, Subsection A, Primer Application. No additional payment will be made for patching damaged areas of a membrane system or for replacing areas of excessive thickness in the liquid membrane system.



1. Flashing Strips Installed First Along Both Curbs.
2. Sheet Membrane is Installed From Each Curb Toward The Center with 2" Min. Transverse Overlap for the Bituthene and Protecto-Wrap Systems; and a 4" Minimum Transverse Overlap for the Royston System.

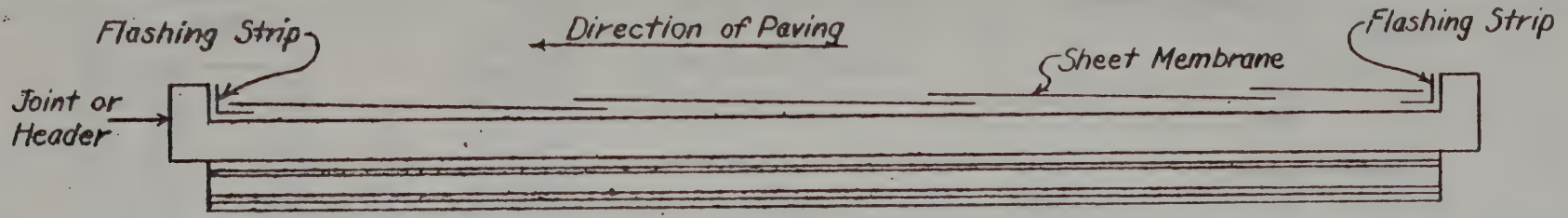
TRANSVERSE SECTION – LEVEL DECK – NO CROSS SLOPE OR NORMAL CROWN



1. Flashing Strip Installed Along Low Curb First.
2. Sheet Membrane is Installed from the Low Curb to the High Curb with 2" Min. Transverse Overlap for the Bituthene and Protecto-Wrap Systems; and a 4" Minimum Transverse Overlap for the Royston System.
3. Flashing Strip Installed Along High Curb last.

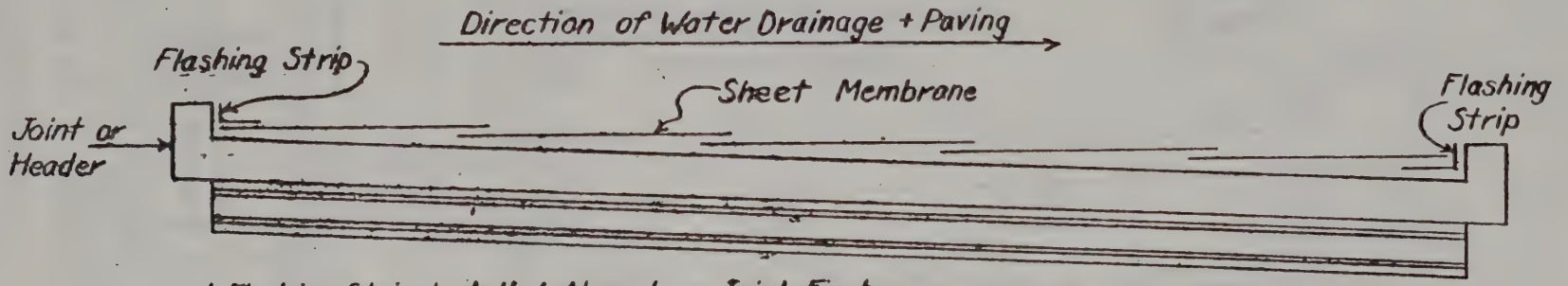
TRANSVERSE SECTION – SUPERELEVATED

9.413



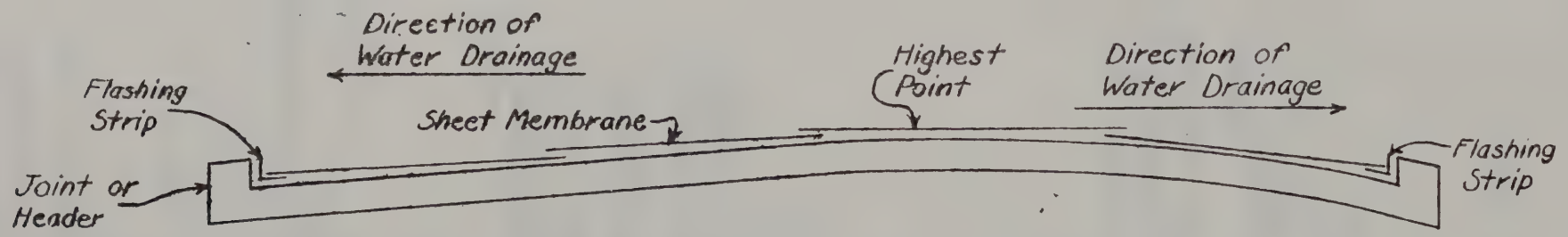
1. Flashing Strips Installed First Along Joints or Headers
2. Sheet Membrane is Installed Opposite the Direction of Paving with 8" Min. Longitudinal Overlaps.

LONGITUDINAL SECTION - 0% GRADE



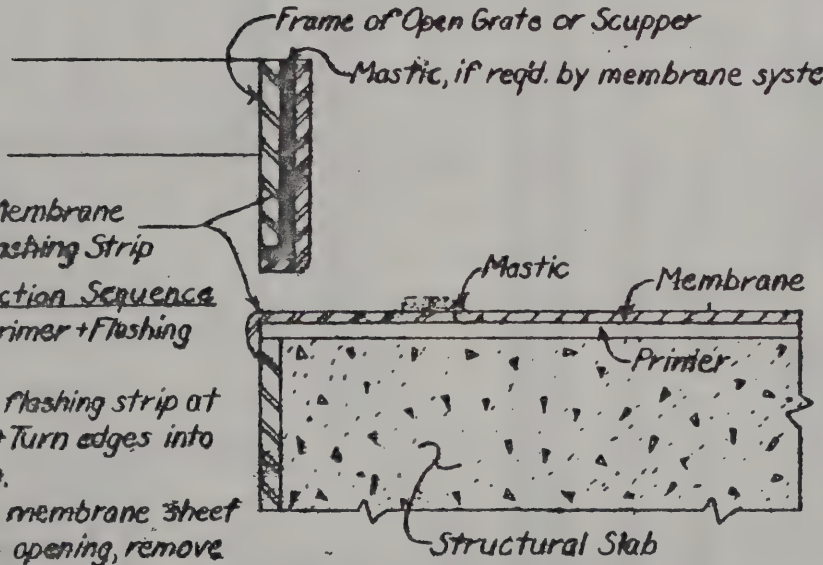
1. Flashing Strip Installed Along Low Joint First
2. Sheet Membrane is installed From the Low end of the slab to the high end with 8" min. Longitudinal Overlaps
3. Flashing Strip Installed Along High joint Last

LONGITUDINAL SECTION - WITH GRADE



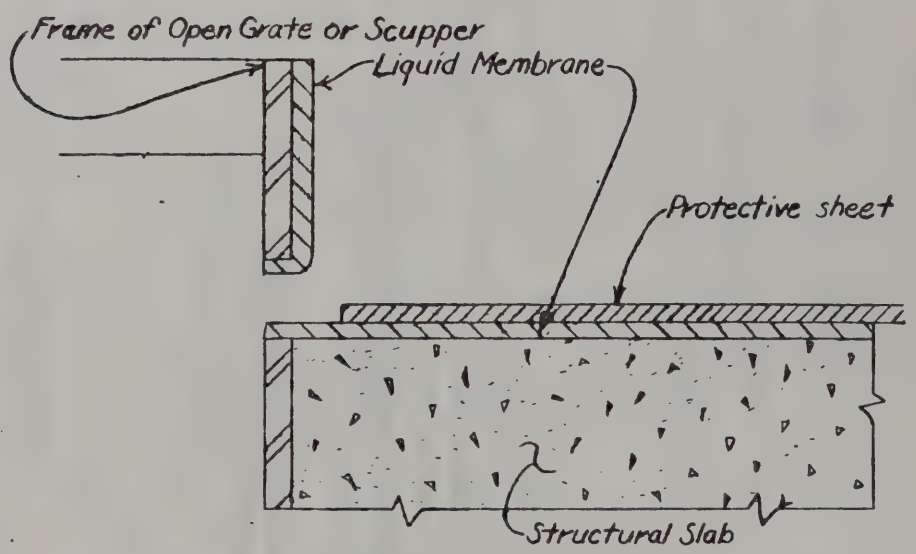
1. Flashing Strips Installed First Along Both Joints or Headers
2. Sheet Membrane is installed From each Joint Toward The Highest Point of the Vertical Curve With 8" Min. Transverse Overlaps

LONGITUDINAL SECTION — VERTICAL CURVE



Construction Sequence
1. Apply primer + Flashing Strip.
2. Pierce flashing strip at Center + Turn edges into Opening.
3. Apply membrane sheet
4. At the opening, remove a portion of the Membrane sheet to make a butt joint.
5. Seal the butt joint with mastic

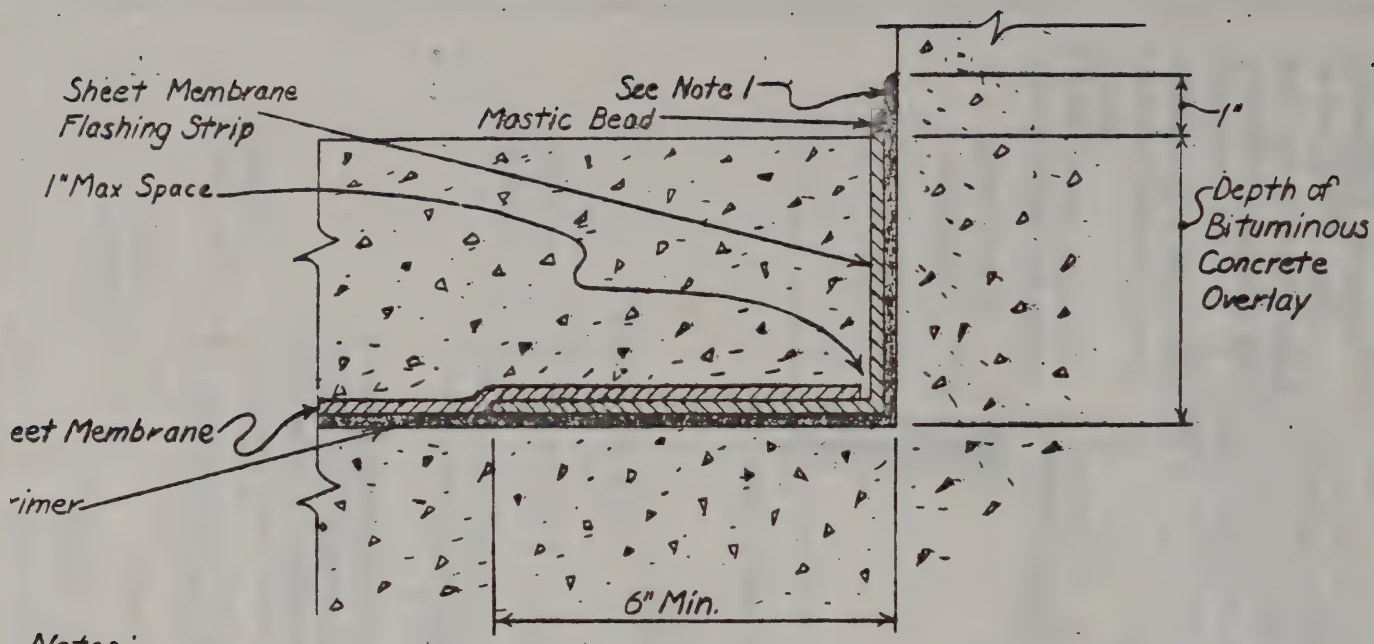
SHEET MEMBRANE



LIQUID MEMBRANE

ALTERNATE SUBDRAINAGE OUTLET DETAILS

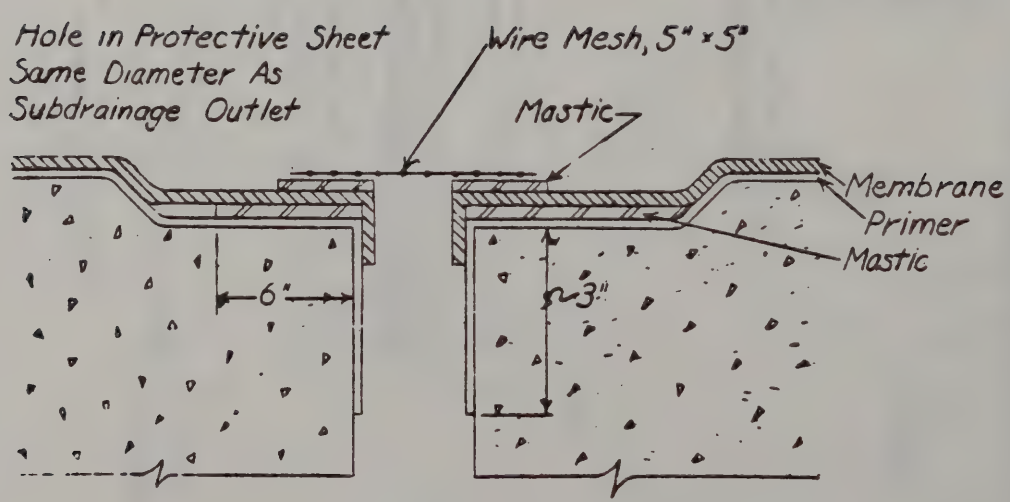
Used where drainage of the membrane is accomplished through slots cut in grates in the structural slab.



Notes:

1. Heavy Duty Bituthene Flashing Strips Shall be Adhered to Rough Vertical Surfaces Such as Granite Curb with Bituthene Mastic. No Additional Treatment is Required for Smooth Surfaces.
   Protecto-Wrap M-400A Flashing Strips Shall be Adhered to All Vertical Surfaces With Protecto-Wrap 160 H Mastic.
   Royston Bridge Membrane No. 10-A Flashing Strips Shall Be Adhered to All Vertical Surfaces Using The Heat Fusion Method.

TYPICAL SHEET MEMBRANE DETAIL

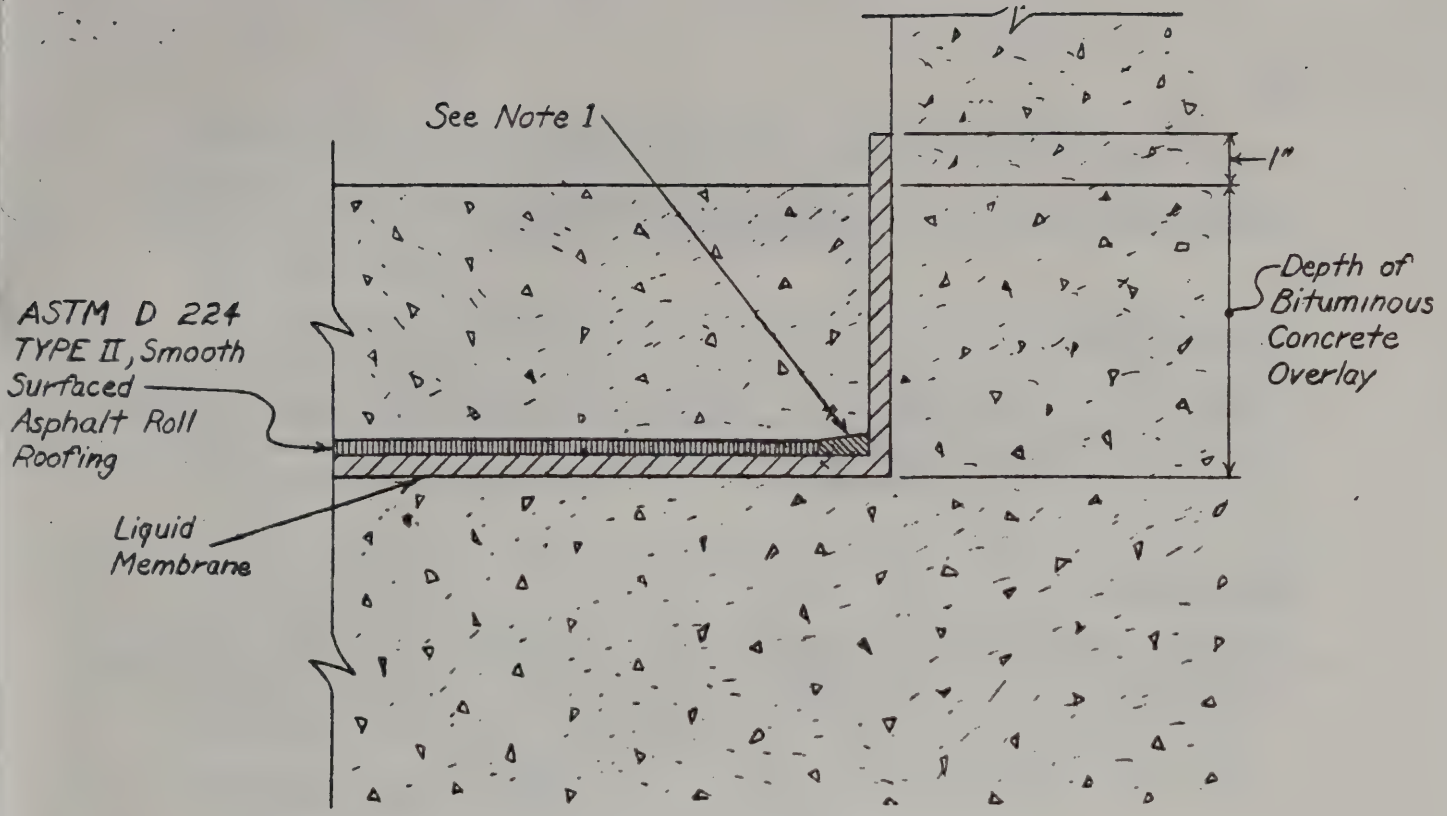


Construction Sequence

1. Primer Extends Down Outlet 3" Min.
2. Apply Mastic Within 6" of Outl
3. Pierce Membrane at center of Outlet And Turn Edges Down
4. Apply Mastic Within 3" of Outle
5. Press 5" x 5" Piece of Wire Me into Mastic

SHEET MEMBRANE DETAIL SUBDRAINAGE OUTLET

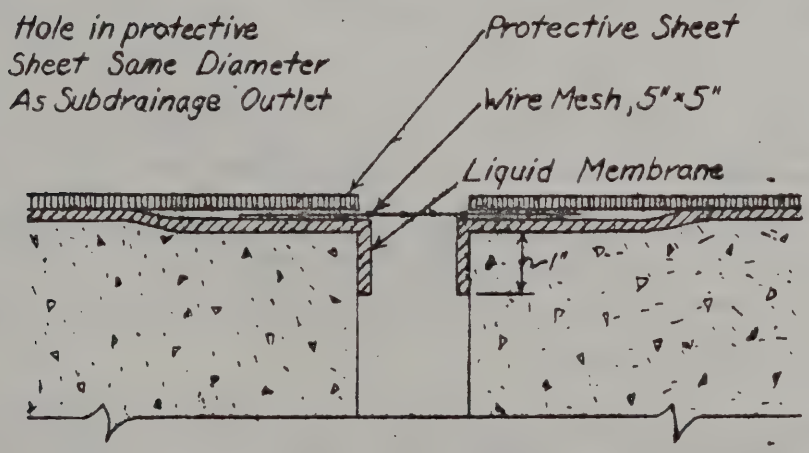
Plate 4



Notes:

1. Gap Between Protective Sheet and Vertical Surface Shall be Filled with Liquid Membrane Material

TYPICAL LIQUID MEMBRANE DETAIL



LIQUID MEMBRANE DETAIL SUBDRAINAGE OUTLET

Plate 5

Rehabilitation of Webster Street Bridge (B.I.N. 4-45304-0)

ITEM 05570.0320 - CLEANING STRUCTURAL STEEL ORTHOTROPIC BRIDGE DECK

DESCRIPTION

This work shall consist of abrasive blast cleaning the entire top surface of the steel orthotropic bridge deck, and abutting surfaces, at the locations indicated on the plans, or where directed by the Engineer.

MATERIALS

Abrasive material for use in blast cleaning work shall be as determined by the Contractor, except that it shall be approved by the Engineer and conform to any Local, State or Federal law, regulation or code. All equipment used for this work shall be subject to approval by the Engineer.

CONSTRUCTION DETAILS

Structural steel deck plate, including welds and the vertical surfaces of steel headers and scuppers, shall be cleaned in accordance with the requirements of SSPC-SP6, No. 6, Commercial Blast Cleaning.

Cleaned steel surfaces shall be defined as follows and visually approximate SSPC-ViS 1, Pictorial Standards BSa 2, CSa 2, or DSa 2, as applicable. It is intended that an acceptable cleaned steel surface will be one from which all oil, grease, dirt, rust scale and foreign matter are completely removed from the surface; and all rust, mill scale and bituminous epoxy have been completely removed except for slight shadows, streaks, or discolorations caused by rust stain, mill scale oxides or slight, tight residues of bituminous epoxy that may remain. If the steel surface(s) is pitted, slight residues of rust or bituminous epoxy in the bottom of pits will be considered acceptable. In all areas at least two-thirds of each square inch of surface shall be free of all visible residues, and the remainder shall be limited to the light discoloration, slight staining or tight residues noted above.

The abutting vertical surfaces of concrete parapet shall be blast cleaned to a height that will be at least one inch higher than the completed asphalt overlay wearing surface. The extent of cleaning shall be such that all evidence of contaminants (bituminous epoxy, asphalt, etc.) are completely removed and that clean, intact concrete is exposed.

No material, membrane, or cleaner shall be allowed to enter the canal water.

All existing bituminous epoxy membrane shall be removed and disposed of, in a manner acceptable to the Engineer.

When daily blasting operations are completed all surfaces shall be cleaned of blasting products and other residue by blowing with compressed air or vacuuming.

"Flash rusting", if it occurs, will not be permitted to remain. All surface areas exhibiting "Flash rust" will be recleaned to the acceptable conditions of this specification, in accordance with SSPC-SP6, at no additional cost. Close coordination with the work under Item 15558.50, Membrane Waterproofing System for Structural Slabs is advised.

METHOD OF MEASUREMENT

The work shall be measured as the number of square feet of surface area of steel orthotropic bridge deck cleaned, as shown on the plans. No separate measurement for vertical surfaces (steel or concrete) shall be made. No deductions will be made for holes less than one square foot in area.

BASIS OF PAYMENT

The unit price bid per square foot shall include the cost of all labor, materials and equipment necessary to complete the work.

Payment will be made under:

ITEM NO.	ITEM	PAY UNIT
05570.0320	Cleaning Structural Steel Orthotropic Bridge Deck	Square Foot

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